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REPORT NO.
335
8 FEBRUARY 1957

FINAL REPORT

HARD ROCK DRILLING

PREPARED FOR
METAL PRODUCTS RESEARCH ASSOCIATES
RESEARCH ORDER NO. 6

PREPARED BY

25X1

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FRONTISPIECE

Figure 1.

Figure 2.

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HARD ROCK DRILLING

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HARD ROCK DRILLING

I INTRODUCTION

This report presents to the Metal Products Research Associates a technical report describing the development of components usable for penetrating and providing openings in thick masonry walls. This report presents the results obtained in the performance of Research Order No. 6 issued under Contract RD-77.

HARD ROCK DRILLING

II PRELIMINARY CONSIDERATIONS

New equipment and techniques have inspired new concepts in engineering design of hard rock drilling and penetration methods. These new techniques have arisen from the use of new drill materials such as the various cemented carbides. Cemented carbide tipped tools have made possible high speed drilling without regard to heating and dulling of the drill point. This has required new concepts of power drives to match the speed and feed capacity of such drills. Thus, the program conducted by the contractor has been concentrated on the development of a drill motor rather than drill bits.

Based upon data furnished to the contractor by the project engineer, it was determined that the output speed of the drill motor should be variable between 2800 rpm and 800 rpm. It was further specified that the power requirements should be supplied directly by human effort. This latter requirement eliminated the consideration of electric motors powered by batteries or by a manually operated generator. Spring driven units were removed from consideration because of the limited length of time during which this type of unit could supply power.

HARD ROCK DRILLING

III DESIGN CRITERIA

With the foregoing considerations in mind, the contractor and project engineer determined that a foot operated unit similar in configuration to a bicycle type exerciser would offer the optimum configuration for transforming the energy of a man into power available for drilling. The operator would sit upon a bicycle seat, grasp a handle bar, and rotate the pedals by foot action. The rotating effort applied to the pedals would then be transmitted by chain or belt drives to a four speed bicycle transmission, and the output shaft of the transmission would be coupled to a flexible output shaft. The output end of the flexible shaft would contain a chuck suitable for holding the drill bit.

A review of data available showed that a man could operate the pedals on a racing bicycle at an average speed of 100 rpm for a long period of time. This data was obtained from bicycle speed and distance records indicating an average speed of 21 mph for six to ten hours of road racing. It has therefore been assumed that a maximum pedal speed of 116 rpm was within reason for the duration of the drilling operations. The decision was then made to use a Sturmey - Archer four-speed bicycle transmission, type F W, and build the frame unit about it. This transmission provides the maximum variation between high speed and low speed that was available commercially. A chain drive from the pedal sprocket to the four-speed

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transmission provides the first stage of the drive, and a Gilmer timing belt drive from the transmission to a right angle gear unit provides the last stage of the drive. The roller chain drive is satisfactory for the first stage as the linear speed of the chain is relatively slow. However, a roller chain drive on the last stage proved unsatisfactory from the standpoint of noise level, but the timing belt drive is quite satisfactory.

Another consideration in the design of the drill unit was that it should be capable of being packaged within a conventional suitcase. In order to comply with this requirement the frame was designed so as to be easily assembled and disassembled without the use of tools. Spring actuated detents and pins are utilized in those joints which must be readily disassembled, and the sprocket crank has been hinged to enable the pedals to be rotated within the frame and thus be packaged in the suitcase.

HARD ROCK DRILLING

IV DETAIL DESIGN

The "bicycle" frame is primarily constructed of aluminum tubing welded together by the heliarc process and is shown in the photographs, Figures 1 and 2, and assembly drawing, 289 - 001. Wherever possible, standard bicycle parts have been used for such parts as the seat, seat post, drive sprocket, sprocket crank, pedals, bearings, chain, and four-speed transmission. The output shafts are standard flexible drive units, Flexarm No. 521, manufactured by S. S. White Dental Manufacturing Co., equipped with their No. 5 Handpiece which is suitable for holding drills up to and including 1/4 inch shank diameter.

The drive mechanism consists of a 1/2 inch pitch by 1/8 inch wide roller chain drive with a speed increase from a 52 tooth drive sprocket to a 14 tooth driven sprocket attached to a Sturmey - Archer type F W four-speed transmission with a speed increase of 26.6%, a 1:1 ratio, and speed reductions of 21% and 33%, a 3/8 inch pitch by 1/2 inch wide Gilmer timing belt drive with a speed increase from a 72 tooth drive pulley clamped to the hub of the transmission to a 14 tooth driven pulley, and a 1:1 right angle gear unit with two output shafts at 90° to one another. Three S. S. White Dental Manufacturing Co. flexible shafts, Flexarm No. 521, in lengths of approximately 5 feet, 9 feet, and 12 feet were furnished with the drill unit. These Flexarm assemblies were not complete in themselves as only one

HARD ROCK DRILLING

motor coupling and one handpiece were furnished for all three shafts. This was done in the interest of reducing the weight of the completed package and also of keeping the cost to a minimum. Two interchangeable chucks have been provided to accept drill shanks up to 1/4 inch in diameter. The flexible drive shaft assembly is rated at 1/4 horsepower at 1750 rpm which is ample for the requirements of this program.

With a pedal speed of 116 rpm and with the top speed of the transmission engaged, the output shaft will rotate at

$$\frac{52}{14} \times \frac{72}{14} \times \frac{1.266}{1} \times 116 = 2800 \text{ rpm}$$

This pedal sprocket speed is well within the capabilities of a man, and the output speed as calculated is the maximum required by the specifications. With the same pedal sprocket speed, and with the transmission engaged in the slowest output speed ratio, the output speed will be

$$\frac{52}{14} \times \frac{72}{14} \times \frac{(1 - .33)}{1} \times 116 = 1480 \text{ rpm}$$

In order to obtain a drill speed of 800 rpm, it will be necessary to decrease the pedal sprocket speed to 63 rpm and to engage slow speed stage of the transmission.

HARD ROCK DRILLING

V CONCLUSION

The prototype unit was delivered to the customer for evaluation. Preliminary information has indicated that this unit operated satisfactorily. However, the energy required to operate the drill through the desired materials over an extended period of time was beyond the output available from a team of three men alternating as operators with each man pedalling for one minute and resting for two minutes.

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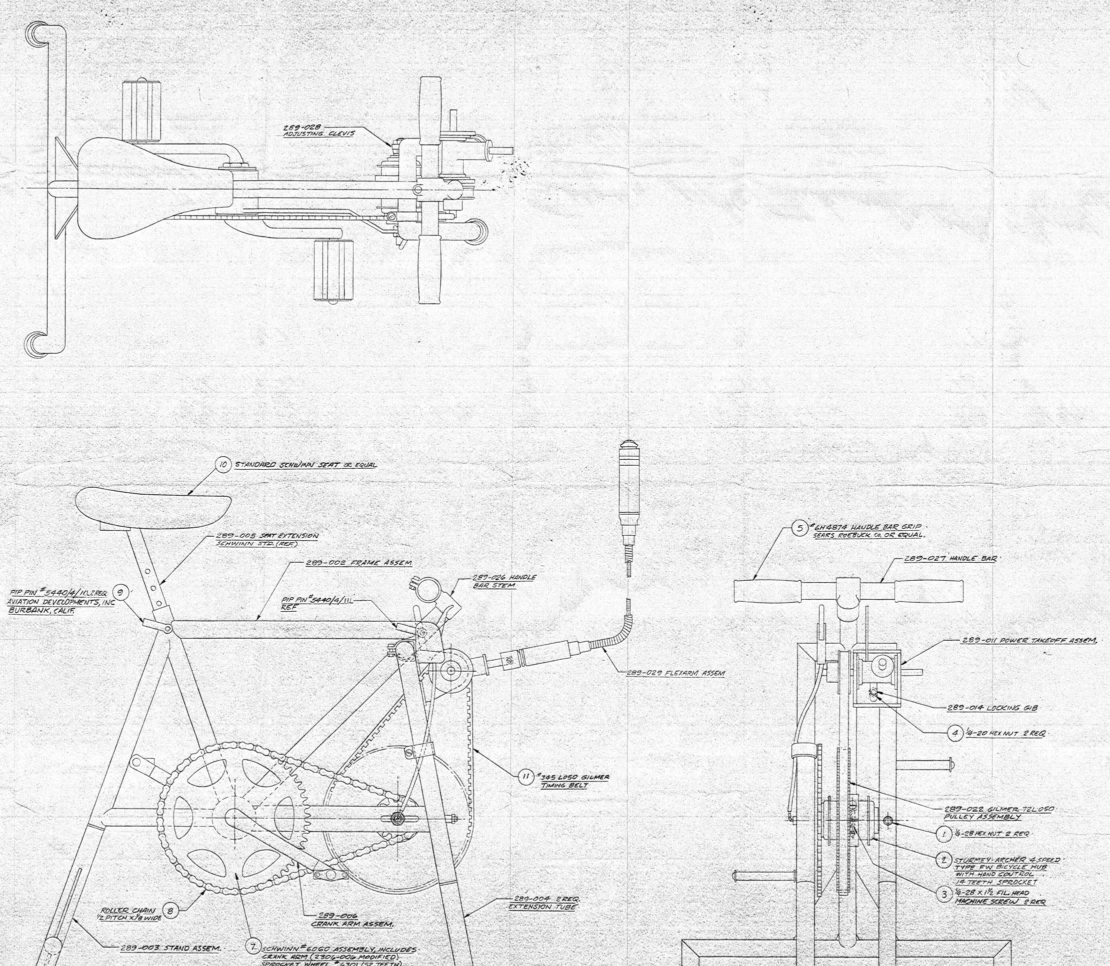

PART NUMBER	QUANTITY REQ.	PART NAME	MATERIAL
	1	STANDARD (2 SUIT) SUITCASE 24" x 18" x 8"	
	1	289-029 FLEXARM ASSEM.	
	1	289-002 FRAME ASSEMBLY	
	1	289-028 ADJUSTING CLEVIS	
	1	289-027 HANDLE BAR	
	1	289-026 HANDLE BAR STEM	
	1	289-022 GILMER PULLEY ASSEM.	
	1	289-014 LOCKING GIB	
	1	289-011 POWER TAKEOFF ASSEM.	
			289-001
	1	289-006 CRANK ARM ASSEM.	
	1	289-005 SEAT EXTENSION	
	2	289-004 EXTENSION TUBE ASSEM.	
	1	289-003 STAND ASSEM.	
-11	1	#345 L050 TIMING BELT	GILMER
-10	1	STANDARD BICYCLE SEAT	SCHWINN OR EQUAL
-9	2	#5440/4/11 L TYPE L PIP PIN	AVIATION DEVELOPMENTS CO.
-8	1	½" PITCH-⅛ WIDE BICYCLE ROLLER CHAIN	SCHWINN
-7	1	#6060 ASSEM CRANK ARM	SCHWINN
-6	4	#9H68941 CRUTCH TIP	SEARS ROEBUCK CO.
-5	2	LH 4874 HANDLE BAR GRIP	SEARS ROEBUCK CO.
-4	2	¼-20 STEEL HEX NUT	COMMERCIAL CAD. PLATE
-3	2	¼-28 x 1½ STEEL FIL. HD. MACH. SCREW	COMMERCIAL CAD. PLATE
-2	1	4 SPEED-TYPE FW BICYCLE HUB	STURMEY-ARCHER CO.
-1	2	¼-28 STEEL HEX NUT	COMMERCIAL CAD. PLATE

MATERIAL	FINISH
DRAWN BY LOOSEN	APPROVED BY RKE
DATE 11/30/56	SCALE HALF SIZE
NEXT ASSEMBLY	MODEL

MANUAL POWER UNIT - PORTABLE DRILL-ASSEMBLY

NO.	DATE	REVISIONS	BY

UNLESS SPECIFIED ALL TOLERANCES ARE: FRACTIONS ± DECIMALS ± ANGLES ±

DWG SIZE R | DWG NO. 289-001 | ISSUE

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